The Effect of Prebiotic and Probiotic Supplementation on Intestinal Maturity in Turkey Poults

Kate Meizlish, Dr. Mike Lilburn, Dr. Macdonald Wick, Stephanie Loeffler

OSU College of Food, Agriculture and Environment Science: Department of Animal Science

Background

In the United States, the agricultural industry uses feed grade antibiotics to help keep animals healthy and productive. Unfortunately, this practice can lead to antibiotic resistant strains of bacteria. The turkey industry is currently searching for an alternative to antibiotics to promote growth as they have been banned in several countries and consumers are willing to pay more for an antibiotic free product.

Probiotics and prebiotics are two possible alternatives to enhance growth in young turkeys by accelerating intestinal maturity.

- **Probiotics** are live, beneficial species of bacteria that naturally populate the small intestine. Logically, if animals consume probiotics which survive the digestion process, some should colonize the GI tract, preventing harmful species from attaching through competitive exclusion.[1]
- **Prebiotics** are composed of both protein and carbohydrate. These compounds are intended as a substrate for beneficial bacteria in order to shift the intestinal population away from harmful bacteria. Additionally, mannan-oligosaccharides bind to certain types of pathogens such as E. coli and prevents them from attaching to the wall of the small intestine.[2]

The health of the gastrointestinal tract can be measured not only by the length and area of absorptive villi, but also by the number and type of goblet cells, a specialized epithelial cell. Goblet cells are responsible for producing mucins, high molecular weight glycoproteins that serve to anchor commensal bacteria and exclude pathogenic species.[3] Acidic mucins in particular help prevent bacterial attachment in young birds.[2]

Hypothesis

Based on previous research,[2] the mannan-oligosaccharides present in the *Saccharomyces cerevisiae* supplement will accelerate intestinal development as measured by both villus parameters and acidic goblet cell count.

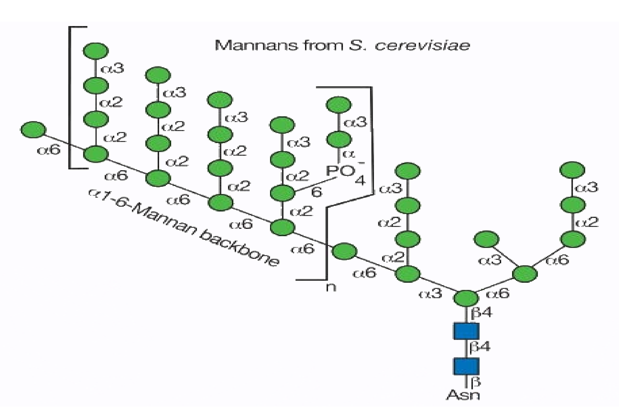

Figure 1. Mannan-oligosaccharide of *S. cerevisiae* which provides the prebiotic effect.[4]

Methods

Turkeys were raised and euthanized by Stephanie Loeffler. All poults were fed adequate commercial diets. Three commercial supplements were provided:

- Probiotic A - *Bacillus subtillus*
- Mannan-Oligosaccharide from Brewer's yeast extract
- Probiotic B - *Bacillus licheniformis*

Sections between the ileo-cecal junction and Meckel's diverticulum were collected upon euthanization at 11 days post hatch.

Blocks were sectioned by OSU CPMPSR Histology/IHC Core Lab. Slides were stained with Alcian Blue pH 2.5 to highlight acidic goblet cells. Measurements and goblet cell counts were done with image J software. Statistical analysis was performed with SAS using ProcGLM.

Results

Diet	Villus Ht (µm)	Villus Area (μm^2)	Crypt Depth (µm)	Acidic Goblet Cells (no.)	Cell Density Height (no./µm)	Cell Density Area (no. $x10^3/\mu m^2$)
Control	1038	286617 ^{a}	205 ^{a}	42.4 ^{c}	.041 ^{b}	.151 ^{c}
Probiotic A	949	208854 ^{c}	175 ^{b}	46.8 ^{b}	.050 ^{a}	.237 ^{a}
MOS	1019	269796 ^{ab}	211 ^{a}	50.5 ^{a}	.051 ^{a}	.202 ^{b}
Probiotic B	1021	256081 ^{ab}	205 ^{a}	52.1 ^{a}	.052 ^{a}	.216 ^{b}
Pooled SEM	6	4772	2	0.6	0.001	0.005
Analysis of Variance	Probability					
Diet	0.122	0.001	0.001	0.001	0.001	0.001

Figure 2. Results of statistical analysis. Superscripts represent Duncan's multiple mean separations, with $p < .05$ as the threshold of significance.

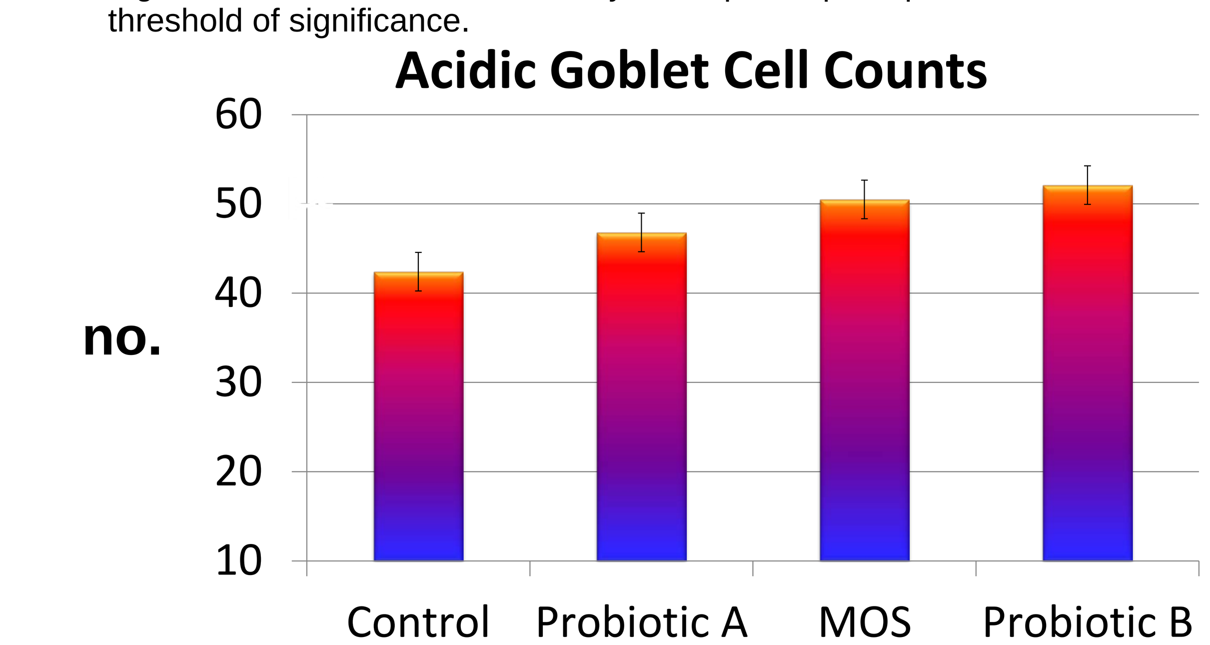

Figure 3. Graph of least square means of acidic goblet cell counts of 100 goblet cells.

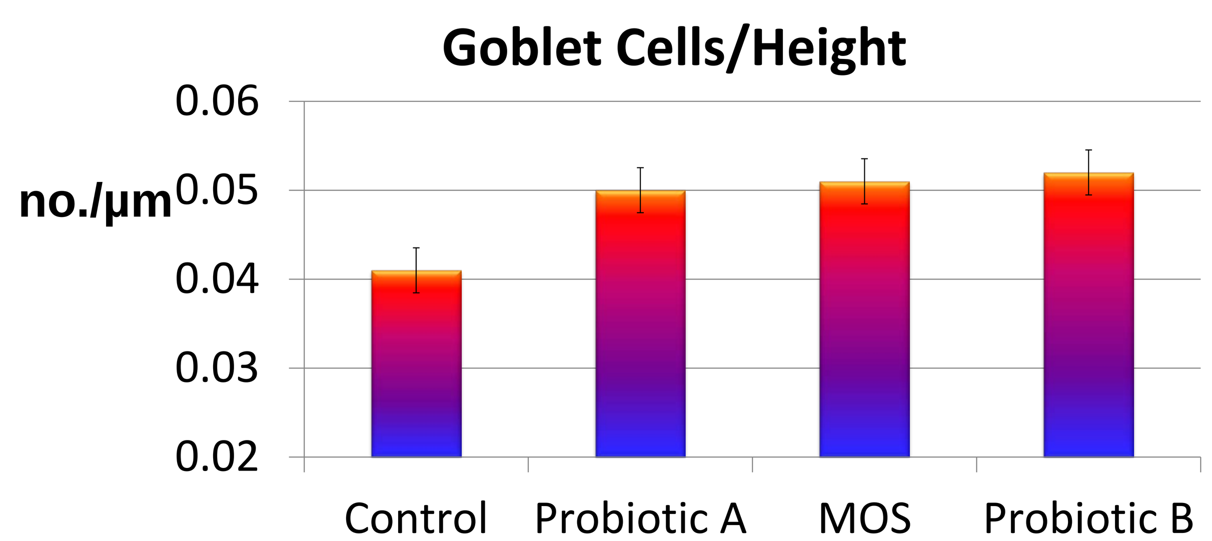

Figure 4. Graph of least square means of acidic goblet cell counts divided by the height of each cell.

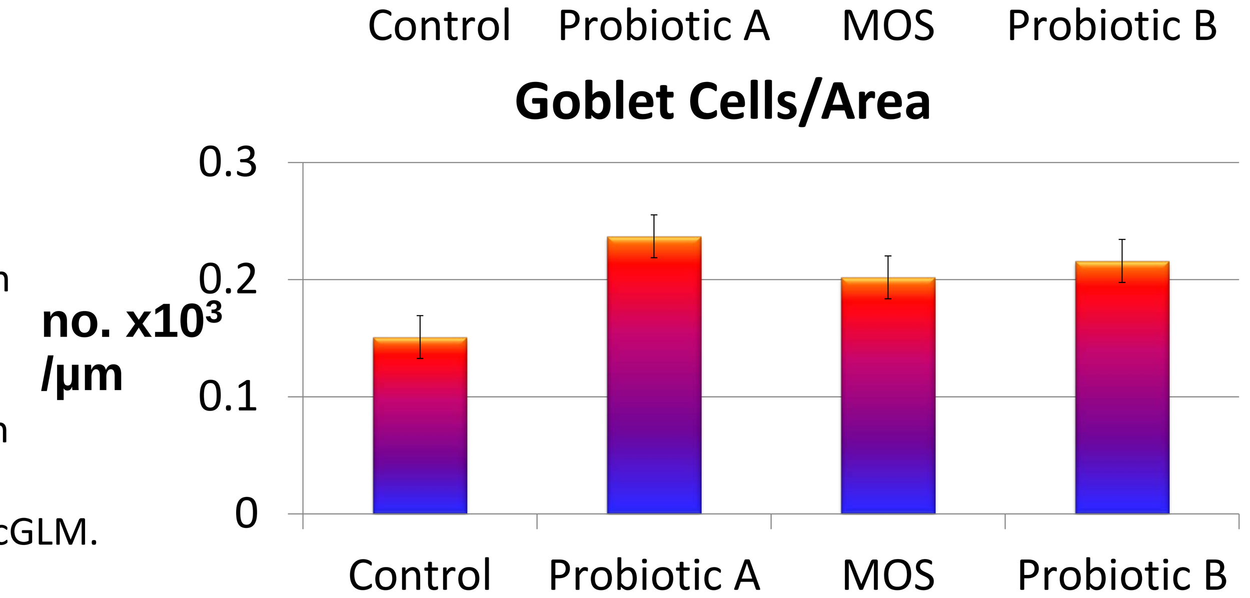

Figure 5. Graph of least square means of acidic goblet cell counts divided by the area of each cell.

Results Cont'd

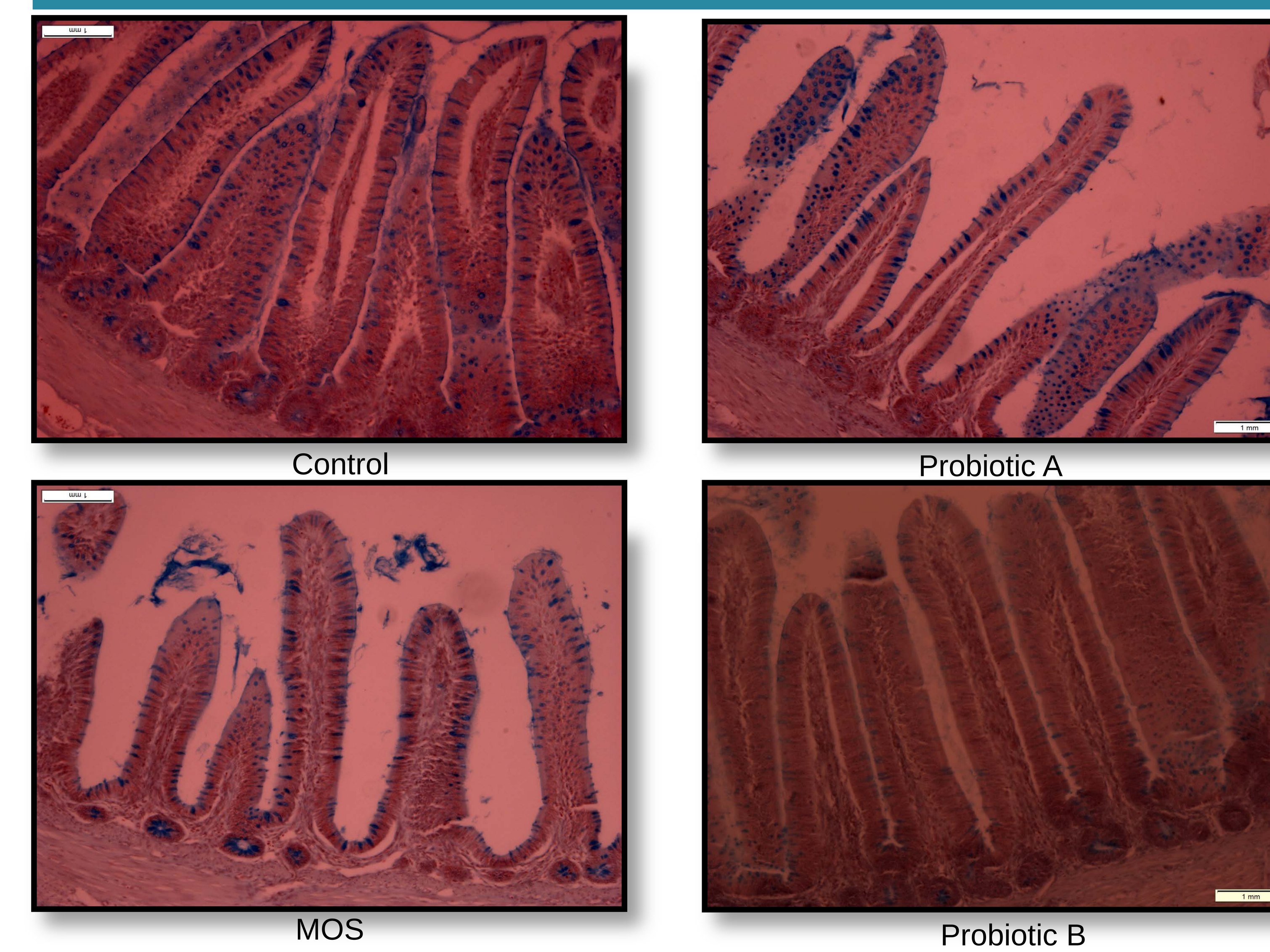

Figure 6. Sections stained with Alcian Blue pH 2.5.

Conclusions

- According to data on goblet cell number and density, all three treatments increased acidic goblet cells over the control. In terms of area, Probiotic A acidic goblet cell density was significantly higher than all other groups. Probiotic A acidic goblet cell number was lower than the other treatment groups but still significantly higher than the control. Thus, all groups showed improvement over the control.
- Probiotic A had significantly lower villus area and crypt depth. This group also had lower villus height, although this number was not significant. This was most likely due to natural variation in population because logically a probiotic should not harm intestinal development.

References

1.Smirnov, A. et al., "Mucin dynamics and microbial populations in chicken small intestine are changed by dietary probiotic and antibiotic growth promoter supplementation." *Journal of Nutrition* 135.2 (2005): 187-192. Print.

2. Solis de los Santos, F. et al., "Gastrointestinal Maturation is Accelerated in Turkey Poults Supplemented with a Mannan-Oligosaccharide Yeast Extract (Alphamune)." Poultry Sci 86.5 (2007): 921-930. Print.

3. Specian, R. and Oliver, M., "Functional biology of intestinal goblet cells." *Am J Physiol* 260.2 pt 1(1991):183-193.Print

4. *Mannan (MOS)*. Nani International Biology.2007. Web. 17 Feb. 2015.

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